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# Phytoremediation of wastewater using *Typha latifolia* (L.)

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**Abstract**
Phytoremediation is continuously driving the attention as a cost effective technique that uses plants to remove contaminants from soil, wastewater and sediments. In this study the ability of *Typha latifolia* (L.) was used to examine its potential application for phytoremediation. Pollutant concentration was measured in samples of wastewater initially and after phytoremediation. Results indicated that *Typha latifolia* (L.) was remarkably efficient in reducing maximum the pH (10.21%), TDS (54.20%), TS (55.23%), BOD (68.76%), COD (62.24%), EC (51.09%), Ca (50.66%), K (53.71%), Mg (47.59%), S (50.91%), P (50.58%), N (49.82%), Fe (53.74%), Mn (52.63%) but it increase the DO (152.79%) of sample in 60 days at 60% level of wastewater. Conclusively the present study demonstrates that *Typha latifolia* (L) have the potential to be used in the phytoremediation of wastewater and further uses is encouraged.

**Keywords:** phytoremediation, *Typha Latifolia*, wastewater

## Introduction

Heavy metals are essential groups of pollutants responsible for the degradation of water quality. They can either derive naturally through weathering processes from parent rock material, or reach the aquatic environment via anthropogenic activities [1]. Phytoremediation, plant usage for remediating natural resources, is being sought as a modern method to clean up polluted lands and streams, including water from ground. Bioremediation assisted by plant, also known as form of phytoremediation, and includes the involvement of microbes associated with certain root systems to remediate soils comprising elevated organic compound concentrations.

*Cattail* or *Typha* occur in the type of various species. Broad-leaved cattail, common cattail (*Typha latifolia* L.) might be found in fairly undisturbed environments, while the leaved cattail is small (*Typha angustifolia* L.). *Typhax glauca*, typically located in more fragile and salty environments [2]. Conservation behavior is generally the same with all 3 plants. It is one of our water-loving plants which is most frequently and easily recalled. Many human beings are well known for our cattail. It is moreover useful in treating municipal and agricultural water [3]. It is put for soaking up and metabolizing contaminants in effluent from black tiger shrimp farms [4]. The plants expand rapidly and suck up large quantities of phosphorus and nutrient from the water [5]. The plants which develop inside the waste material would then be used as animal feed, similar to carp [6] fish genus of the Nile River [7].

## Material and Methods

Test method used for the analysis is according to standard methods for examination of water and waste water published by American Public Health Association. *Typha latifolia* (L.) plants which serve as tool of phytoremediation were collected from nature. They were rinsed with tap water to remove possible contamination. T*ypha* latifolia (L.) experiment were carried out in 30 L capacity plastic container. T*ypha latifolia* (L.) plant of approx. 30.00 gm were inoculated in each plastic container. Three replicate were taken for each treatment. The treatment level for experiment were:- (i) Control (pond water), (ii) 20 percent waste water, (iii) 40 percent waste water, (iv) 60 percent waste water, (v) 80 percent waste water, (vi) 100 percent waste water. For study, samples were drawn and estimations were made for physico-chemical characteristics of waste water before and after treatment of 15, 30 and 60 days growth of *Typha latifolia* (L.) plants.

### Physicochemical analysis

Following physico-chemical properties were studied. pH was measured by B.D.H. universal indicator; TDS were determined by method described in IBP Hand Book No. 8.; TS can be determined as the residue left after evaporation of the unfiltered sample; BOD were determined as per standard method described by Greenberg, *et al*., 1980 [8]; COD and EC was determined by method of Tripathi and Govil, 2001 [9]; DO were estimated by method of Winkler's modified iodide-azide; Calcium, Phosphate & Potassium were measured by method of Wallace, 1951[10]; Magnesium was determined by titan yellow method described by Mason, 1950 [11]; Sulphate was determined by the method of Chesnin and Yen, 1951 [12] described by Jackson, 1958[13]; Nitrogen was determined by semi-microkjeldahl method of Chibnall *et al.*,1943 [14]; Iron was measured by the method described by Humphries,1956 [15]; Manganese was determined by method described by Nicholas and Fischer, 1950[16] while Percent removal rates of contaminant are used to distinguish the volume of the removed contaminant among aquatic plants grown in wastewater[17].

## Results and Discussion

### pH

After treatment by aquatic plants *Typha latifolia* (L.), the control value of pH in 15, 30 and 60 days is 7.19 + 0.04, 7.13 + 0.03 and 7.06 + 0.03 respectively. After treatment, the reduced value of pH in 15, 30 and 60 days was 7.29 + 0.05, 7.25 + 0.06 and 7.14 + 0.05 respectively at 20%, 7.53 + 0.08, 7.36 + 0.06 and 7.25 + 0.05 at 40% respectively, 7.76 + 0.09, 7.55 + 0.06 and 7.30 + 0.05 respectively at 60%, 8.05 + 0.09, 7.83 + 0.06 and 7.66 + 0.06 respectively at 80% while 8.48 + 0.06, 8.37 + 0.04 and 8.23 + 0.04 respectively at 100% wastewater. The pH value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 4.55%, 7.13% and 10.21%. Our findings are in support of Kumar *et al*., 2019[18] who studied that the pH of the sewage effluent tends to get decreased. In another study, a decrease in pH [19] was observed due to $CO_2$ output from decomposing wastewater and plant litter stuck on its root mat to the ammonia nitrification.

**Total Dissolve solids (TDS)**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of TDS in 15, 30 and 60 days are 316.72 + 0.06 mg/l, 306.64 + 0.05 mg/l and 285.51 + 0.03 mg/l respectively. After treatment, the reduced value of TDS in 15, 30 and 60 days was 440.44 + 0.07 mg/l, 396.16 + 0.04 mg/l and 337.78 + 0.04 mg/l respectively at 20%, 596.16 + 0.09 mg/l, 485.68 + 0.09 mg/l and 386.25 + 0.08 mg/l at 40% respectively, 720.88 + 0.07 mg/l, 545.21 + 0.07 mg/l and 430.61 + 0.07 mg/l respectively at 60%, 875.60 + 0.06 mg/l, 664.73 + 0.06 mg/l and 554.82 + 0.05 mg/l respectively at 80% while 1170.31 + 0.06 mg/l, 1104.25 + 0.06 mg/l and 1022.20 + 0.06 mg/l respectively at 100% wastewater. The TDS value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 23.33%, 42.01% and 54.20%. The sediment, filtration and adsorption decreased the TDS value [20]. This is in line with findings of Suganya and Paul Sebastian, 2017[21].

**Total Solids (TS)**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of TS in 15, 30 and 60 days is 383.20 + 0.06 mg/l, 366.89 + 0.05 mg/l and 342.24 + 0.03 mg/l respectively. After treatment, the reduced value of TS in 15, 30 and 60 days was 640.07 + 0.07 mg/l, 541.73 + 0.06 mg/l and 470.57 + 0.06 mg/l respectively at 20%, 914.95 + 0.08 mg/l, 714.57 + 0.08 mg/l and 588.91 + 0.08 mg/l at 40% respectively, 1168.82 + 0.08 mg/l, 887.43 + 0.07 mg/l and 737.25 + 0.06 mg/l respectively at 60%, 1498.70 + 0.06 mg/l, 1160.27 + 0.06 mg/l and 935.59 + 0.06 mg/l respectively at 80% while 2127.57 + 0.06 mg/l, 1933.11 + 0.06 mg/l and 1812.54 + 0.03 mg/l respectively at 100%. The TS value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 29.02%, 46.11% and 55.23%. Our findings are in support with Wu, 2014 [22] who showed reduction in TS i.e. 45.30**.**

**Biochemical Oxygen Demand (BOD)**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of BOD in 15, 30 and 60 days is 6.33 + 0.05 mg/l, 6.08 + 0.04 mg/l and 5.86 + 0.03 mg/l respectively. After treatment, the reduced value of BOD in 15, 30 and 60 days was 28.59 + 0.07 mg/l, 22.85 + 0.06 mg/l and 20.55 + 0.06 mg/l respectively at 20%, 49.36 + 0.08 mg/l, 37.95 + 0.08 mg/l and 30.00 + 0.07 mg/l at 40% respectively, 66.96 + 0.07 mg/l, 48.18 + 0.07 mg/l and 34.51 + 0.07 mg/l respectively at 60%, 90.15 + 0.07 mg/l, 65.15 + 0.06 mg/l and 49.49 + 0.06 mg/l respectively at 80% while 144.34 + 0.06 mg/l, 132.13 + 0.04 mg/l and 120.47 + 0.04 mg/l respectively at 100%. The BOD value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 39.39%, 56.39% and 68.76%. This is consistent with the results of Sankar, 2000[23] and Kadlec and Knight, 1996[24] which show that these plants have root zones and thus allow degradation of organic matter and thus decrease BOD.

**Chemical Oxygen Demand (COD)**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of COD in 15, 30 and 60 days is 46.76 + 0.05 mg/l, 44.73 + 0.04 mg/l and 42.27 + 0.04 mg/l respectively. After treatment, the reduced value of COD in 15, 30 and 60 days was 131.20 + 0.07 mg/l, 108.94 + 0.06 mg/l and 90.37 + 0.06 mg/l respectively at 20%, 182.92 + 0.07 mg/l, 149.46 + 0.06 mg/l and 124.36 + 0.06 mg/l at 40% respectively, 240.57 + 0.08 mg/l, 207.38 + 0.06 mg/l and 168.12 + 0.06 mg/l respectively at 60%, 332.88 + 0.07 mg/l, 272.43 + 0.07 mg/l and 220.37 + 0.06 mg/l respectively at 80% while 520.89 + 0.06 mg/l, 490.57 + 0.06 mg/l and 468.32 + 0.04 mg/l respectively at 100%. The COD value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 45.97 %, 53.43 % and 62.24 %. This number is consistent with Mashauri *et al*., 2000 [25] findings that longer time for retention decreases COD. The elimination of chemical oxygen demand is due to microbial deterioration of the roots of the plants [26, 27].

**Electrical Conductivity (EC)**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of EC in 15, 30 and 60 days are 565.24 + 0.04 $\mu Scm^{-1}$, 543.58 + 0.04 $\mu Scm^{-1}$ and 512.42 + 0.02 $\mu Scm^{-1}$ respectively. After treatment, the reduced value of EC in 15, 30 and 60 days was 865.23 + 0.08 $\mu Scm^{-1}$, 802.63 + 0.07 $\mu Scm^{-1}$ and 720.65 + 0.07 $\mu Scm^{-1}$ respectively at 20%, 1140.46 + 0.09 $\mu Scm^{-1}$, 998.74 + 0.08 $\mu Scm^{-1}$ and 776.23 + 0.08 $\mu Scm^{-1}$ at 40% respectively, 1398.54 + 0.08 $\mu Scm^{-1}$, 1196.86 + 0.07 $\mu Scm^{-1}$ and 986.54 + 0.07 $\mu Scm^{-1}$ respectively at 60%, 1731.56 + 0.06 $\mu Scm^{-1}$, 1495.25 + 0.06 $\mu Scm^{-1}$ and 1226.51 + 0.06 $\mu Scm^{-1}$ respectively at 80% while 2356.87 + 0.06 $\mu Scm^{-1}$, 2276.82 + 0.06 $\mu Scm^{-1}$ and 2046.82 + 0.04 $\mu Scm^{-1}$ respectively at 100%. The EC value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 30.66%, 40.66% and 51.09%. Due to evapotranspiration or substratum motions by accumulated plant roots in this effect, electrical conductivity was decreased [28]. The decline in conductance amid significant water losses is due to the absorption from plant roots, litters, and settleable suspended particles of macro and micro elements and ions [29]**.**

**Dissolve Oxygen (DO)**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of DO in 15, 30 and 60 days is 6.72 + 0.04 mg/l, 7.01 + 0.03 mg/l and 7.28 + 0.03 mg/l respectively. After treatment, the increased value of DO in 15, 30 and 60 days was 7.88 + 0.07 mg/l, 9.12 + 0.07 mg/l and 9.98 + 0.06 mg/l respectively at 20%; 6.88 + 0.09 mg/l, 8.18 + 0.09 mg/l and 9.35 + 0.08 mg/l at 40% respectively; 5.39 + 0.08 mg/l, 6.42 + 0.07 mg/l and 7.71 + 0.06 mg/l respectively at 60%; 3.65 + 0.06 mg/l, 4.34 + 0.06 mg/l and 5.23 + 0.05 mg/l respectively at 80% while 1.37 + 0.06 mg/l, 1.51 + 0.04 mg/l and 1.56 + 0.04 mg/l respectively at 100%. The DO value increased maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 76.72%, 110.49% and 152.79%. In his study, DO of wastewater lies in range between 2.35 and 3.56 mg/L and increased by 125% [30]. For *T. latifolia*, average DO performance was the best. In root-areas of plant which have higher aerenchymatic tissues, such as *T. latifolia*, additional oxygen has been released and the vegetation considered having substantial root systems displays greater rhizosphere removal efficiency [31]. Production of oxygen depends on the type of plants [32, 33].

**Calcium**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of calcium in 15, 30 and 60 days is 42.76 + 0.04 mg/l, 41.12 + 0.03 mg/l and 39.23 + 0.02 mg/l respectively. After treatment, the reduced value of calcium in 15, 30 and 60 days was 77.80 + 0.08 mg/l, 70.24 + 0.07 mg/l and 60.38 + 0.06 mg/l respectively at 20%; 112.56 + 0.08 mg/l, 97.99 + 0.08 mg/l and 79.00 + 0.07 mg/l at 40% respectively; 147.34 + 0.07 mg/l, 125.76 + 0.07 mg/l and 97.62 + 0.07 mg/l respectively at 60%; 186.10 + 0.07 mg/l, 157.51 + 0.06 mg/l and 124.24 + 0.06 mg/l respectively at 80% while 241.42 + 0.06 mg/l, 216.86 + 0.06 mg/l and 199.57 + 0.04 mg/l respectively at 100%. The Ca value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 25.53%, 36.44% and 50.66%. Similar findings were also assessed by Oladejo and Olanipekun, 2018 [34].

**Potassium**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of potassium in 15, 30 and 60 days is 24.64 + 0.03 mg/l, 23.96 + 0.02 mg/l and 22.98 + 0.02 mg/l respectively. After treatment, the reduced value of potassium in 15, 30 and 60 days was 35.77 + 0.08 mg/l, 32.81 + 0.07 mg/l and 27.77 + 0.07 mg/l respectively at 20%; 47.51 + 0.08 mg/l, 41.81 + 0.08 mg/l and 33.13 + 0.07 mg/l at 40% respectively; 59.26 + 0.07 mg/l, 50.97 + 0.06 mg/l and 38.47 + 0.06 mg/l respectively at 60%; 72.00 + 0.07 mg/l, 63.13 + 0.06 mg/l and 47.83 + 0.06 mg/l respectively at 80% while 102.23 + 0.06 mg/l, 95.32 + 0.04 mg/l and 85.29 + 0.04 mg/l respectively at 100%. The potassium value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 28.70%, 38.67% and 53.71%. Our findings are in favour of Alalade *et al*., 2017 [35].

**Magnesium**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of magnesium in 15, 30 and 60 days is 17.60 + 0.04 mg/l, 17.14 + 0.03 mg/l and 16.76 + 0.03 mg/l respectively. After treatment, the reduced value of magnesium in 15, 30 and 60 days was 32.30 + 0.08 mg/l, 28.50 + 0.08 mg/l and 25.30 + 0.07 mg/l respectively at 20%; 46.55 + 0.08 mg/l, 39.99 + 0.08 mg/l and 34.52 + 0.07 mg/l at 40% respectively; 59.81 + 0.08 mg/l, 51.13 + 0.07 mg/l and 44.83 + 0.06 mg/l respectively at 60%; 75.06 + 0.07 mg/l, 63.97 + 0.06 mg/l and 56.12 + 0.05 mg/l respectively at 80% while 104.31 + 0.06 mg/l, 96.46 + 0.04 mg/l and 87.43 + 0.04 mg/l respectively at 100%. The Mg value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 30.08%, 40.23% and 47.59%. Rooted macrophytes in hydroponic analysis magnesium are removed from urban wastewater by 14-85% of heavy metals [36].

**Sulphur**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of sulphur in 15, 30 and 60 days is 20.06 + 0.04 mg/l, 19.51 + 0.03 mg/l and 18.65 + 0.03 mg/l respectively. After treatment, the reduced value of sulphur in 15, 30 and 60 days was 27.92 + 0.07 mg/l, 24.76 + 0.07 mg/l and 22.38 + 0.06 mg/l respectively at 20%; 38.33 + 0.08 mg/l, 33.46 + 0.08 mg/l and 28.10 + 0.08 mg/l at 40% respectively; 47.72 + 0.07 mg/l, 39.14 + 0.06 mg/l and 32.12 + 0.06 mg/l respectively at 60%; 57.55 + 0.07 mg/l, 49.44 + 0.06 mg/l and 41.00 + 0.06 mg/l respectively at 80% while 78.26 + 0.06 mg/l, 69.10 + 0.05 mg/l and 63.87 + 0.04 mg/l respectively at 100%. The sulphur value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 27.07%, 40.18% and 50.91%. Sulphur levels are 55-113 mg / L in another study. The final removal rate for both *T. latifolia* was 66.28 percent in average [30].

**Phosphorus**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of phosphorus in 15, 30 and 60 days is 0.70 + 0.03 mg/l, 0.68 + 0.03 mg/l and 0.66 + 0.03 mg/l respectively. After treatment, the reduced value of phosphorus in 15, 30 and 60 days was 1.50 + 0.06 mg/l, 1.39 + 0.06 mg/l and 1.31 + 0.04 mg/l respectively at 20%; 2.29 + 0.08 mg/l, 2.04 + 0.07 mg/l and 1.73 + 0.07 mg/l at 40% respectively; 3.13 + 0.07 mg/l, 2.65 + 0.06 mg/l and 2.12 + 0.06 mg/l respectively at 60%; 3.98 + 0.06 mg/l, 3.45 mg/l + 0.06 and 2.97 + 0.05 mg/l respectively at 80% while 5.66 + 0.06 mg/l, 5.32 + 0.04 mg/l and 4.98 + 0.04 mg/l respectively at 100%. The P value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 27.04%, 38.23% and 50.58%. For phosphorus, 94.11 and 97.62 percent efficiency were recorded as the most effective removal, whereas other tests recorded different removal speeds [37].

**Nitrogen**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of nitrogen in 15, 30 and 60 days is 11.17 + 0.04 mg/l, 10.92 + 0.03 mg/l and 10.52 + 0.03 mg/l respectively. After treatment, the reduced value of nitrogen in 15, 30 and 60 days was 17.83 + 0.07 mg/l, 16.36 + 0.07 mg/l and 14.95 + 0.06 mg/l respectively at 20%; 22.57 + 0.08 mg/l, 19.76 + 0.08 mg/l and 16.63 + 0.08 mg/l at 40% respectively; 27.62 + 0.07 mg/l, 24.14 + 0.07 mg/l and 19.44 + 0.06 mg/l respectively at 60%; 34.28 + 0.06 mg/l, 30.05 + 0.06 mg/l and 24.56 + 0.05 mg/l respectively at 80% while 46.25 + 0.06 mg/l, 43.23 + 0.06 mg/l and 40.86 + 0.04 mg/l respectively at 100%. The N value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 28.70%, 37.69% and 49.82%. The treatment of waste water is also an important advantage for its use in aquaculture, i.e. *Typha angustifolia* removed ammonia, nitrate and nitrite efficiently [38]. We also demonstrated a decrease in nitrates after passage through the two stages of purification for the two plants tested. Thus, the main mechanisms for removing nitrogen in a wet environment are nitrification and denitrification [39, 40].

**Iron**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of iron in 15, 30 and 60 days is 0.24 + 0.03 mg/l, 0.22 + 0.03 mg/l and 0.20 + 0.03 mg/l respectively.

After treatment, the reduced value of iron in 15, 30 and 60 days was 0.52 + 0.04 mg/l, 0.45 + 0.03 mg/l and 0.39 + 0.03 mg/l respectively at 20%; 0.80 + 0.05 mg/l, 0.70 + 0.05 mg/l and 0.55 + 0.04 mg/l at 40% respectively; 1.06 + 0.07 mg/l, 0.92 + 0.06 mg/l and 0.68 + 0.06 mg/l respectively at 60%; 1.35 + 0.08 mg/l, 1.18 + 0.07 mg/l and 0.92 + 0.06 mg/l respectively at 80% while 1.76 + 0.06 mg/l, 1.63 + 0.04 mg/l and 1.47 + 0.04 mg/l respectively at 100%. The Fe value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 27.89 %, 37.42 % and 53.74 %. Maine *et al*., 2001 [41] have also recorded *Typha latifolia* (L.) even better over-the-two more diversified aquatic plant survival and removal performance in iron, zinc, nickel, and chromium. Aquatic plant *Typha* showed removal rate for iron (44%) studied by Morari *et al*., 2015 [42].

**Manganese (Mn)**

After treatment by aquatic plants *Typha latifolia* (L.), the control value of manganese in 15, 30 and 60 days is 0.013 + 0.002 mg/l, 0.011 + 0.002 mg/l and 0.010 + 0.002 mg/l respectively. After treatment, the reduced value of manganese in 15, 30 and 60 days was 0.038 + 0.003 mg/l, 0.033 + 0.002 mg/l and 0.029 + 0.002 mg/l respectively at 20%; 0.061 + 0.007 mg/l, 0.053 + 0.007 mg/l and 0.042 + 0.007 mg/l at 40% respectively; 0.078 + 0.007 mg/l, 0.068 + 0.006 mg/l and 0.054 + 0.006 mg/l respectively at 60%; 0.104 + 0.006 mg/l, 0.092 + 0.005 mg/l and 0.072 + 0.005 mg/l respectively at 80% while 0.142 + 0.006 mg/l, 0.121 + 0.004 mg/l and 0.108 + 0.003 mg/l respectively at 100%. The Mn value reduced maximum in 15, 30 and 60 days is at 60% of wastewater i.e. 31.58%, 40.35% and 52.63%. During the first 48 hours of analysis, *Typha domingensis* root and shooting tissue showed maximal accumulation of Mn in pots of urban wastewater [43].

**Table 1:** Effect on physico-chemical parameter of wastewater by *Typha latifolia* (L.)

| **Parameters** | | **Days** | **Percentage Wastewater** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **C** | **20** | **40** | **60** | **80** | **100** |
| pH | B.T. | | 7.30 ± 0.02 | 7.59± 0.03 | 7.87± 0.04 | 8.13± 0.06 | 8.42± 0.07 | 8.65 ± 0.04 |
| | A. T. | 15 | 7.19± 0.04 | 7.29 ± 0.05 | 7.53± 0.08 | 7.76± 0.09 | 8.05± 0.09 | 8.48± 0.06 |
| | | 30 | 7.13± 0.03 | 7.25± 0.06 | 7.36± 0.06 | 7.55± 0.06 | 7.83± 0.06 | 8.37± 0.04 |
| | | 60 | 7.06± 0.03 | 7.14± 0.05 | 7.25± 0.05 | 7.30± 0.05 | 7.66± 0.06 | 8.23± 0.04 |
| TDS (mg/l) | B.T. | | 340.77± 0.05 | 546.91± 0.06 | 748.03± 0.07 | 940.17± 0.08 | 1130.30± 0.09 | 1321.43± 0.06 |
| | A. T. | 15 | 316.72± 0.06 | 440.44± 0.07 | 596.16± 0.09 | 720.88± 0.07 | 875.60± 0.06 | 1170.31± 0.06 |
| | | 30 | 306.64± 0.05 | 396.16± 0.04 | 485.68± 0.09 | 545.21± 0.07 | 664.73± 0.06 | 1104.25± 0.06 |
| | | 60 | 285.51± 0.03 | 337.78± 0.04 | 386.25± 0.08 | 430.61± 0.07 | 554.82± 0.05 | 1022.20± 0.06 |
| T. S. (mg/l) | B.T. | | 417.25 ± 0.04 | 839.08± 0.06 | 1255.91± 0.06 | 1646.73± 0.07 | 2069.57± 0.09 | 2476.39± 0.06 |
| | A. T. | 15 | 383.20± 0.06 | 640.07± 0.07 | 914.95± 0.08 | 1168.82± 0.08 | 1498.70± 0.06 | 2127.57± 0.06 |
| | | 30 | 366.89± 0.05 | 541.73± 0.06 | 714.57± 0.08 | 887.43± 0.07 | 1160.27± 0.06 | 1933.11± 0.06 |
| | | 60 | 342.24± 0.03 | 470.57± 0.06 | 588.91± 0.08 | 737.25± 0.06 | 935.59± 0.06 | 1812.54± 0.03 |
| B. O. D. (mg/l) | B.T. | | 6.69± 0.02 | 42.61± 0.04 | 77.54± 0.06 | 110.47± 0.08 | 143.40± 0.09 | 176.32± 0.03 |
| | A. T. | 15 | 6.33± 0.05 | 28.59± 0.07 | 49.36± 0.08 | 66.96± 0.07 | 90.15± 0.07 | 144.34± 0.06 |
| | | 30 | 6.08± 0.04 | 22.85± 0.06 | 37.95± 0.08 | 48.18± 0.07 | 65.15± 0.06 | 132.13± 0.04 |
| | | 60 | 5.86± 0.03 | 20.55± 0.06 | 30.00± 0.07 | 34.51± 0.07 | 49.49± 0.06 | 120.47± 0.04 |
| C.O. D. (mg/l) | B.T. | | 50.17± 0.03 | 191.25± 0.04 | 312.46± 0.06 | 445.27± 0.07 | 576.80± 0.09 | 704.55 ± 0.06 |
| | A. T. | 15 | 46.76± 0.05 | 131.20± 0.07 | 182.92± 0.07 | 240.57± 0.08 | 332.88± 0.07 | 520.89± 0.06 |
| | | 30 | 44.73± 0.04 | 108.94± 0.06 | 149.46± 0.06 | 207.38± 0.06 | 272.43± 0.07 | 490.57± 0.06 |
| | | 60 | 42.27± 0.04 | 90.37± 0.06 | 124.36± 0.06 | 168.12± 0.06 | 220.37± 0.06 | 468.32± 0.04 |
| E. C. (μScm$^{-1}$) | B.T. | | 605.07± 0.03 | 1089.01± 0.04 | 1562.93± 0.06 | 2016.87± 0.06 | 2470.79± 0.08 | 2924.73 ± 0.04 |
| | A. T. | 15 | 565.24± 0.04 | 865.23± 0.08 | 1140.46± 0.09 | 1398.54± 0.08 | 1731.56± 0.06 | 2356.87± 0.06 |
| | | 30 | 543.58± 0.04 | 802.63± 0.07 | 998.74± 0.08 | 1196.86± 0.07 | 1495.25± 0.06 | 2276.82± 0.06 |
| | | 60 | 512.42± 0.02 | 720.65± 0.07 | 776.23± 0.08 | 986.54± 0.07 | 1226.51± 0.06 | 2046.82± 0.04 |
| Parameters | | Days | Percentage Wastewater | | | | | |
| | | | C | 20 | 40 | 60 | 80 | 100 |
| D. O. (mg/l) | B.T. | | 5.94 ± 0.03 | 4.96± 0.06 | 3.98± 0.06 | 3.05± 0.07 | 2.10± 0.08 | 1.15 ± 0.04 |
| | A.T. | 15 | 6.72± 0.04 | 7.88± 0.07 | 6.88± 0.09 | 5.39± 0.08 | 3.65± 0.06 | 1.37± 0.06 |
| | | 30 | 7.01± 0.03 | 9.12± 0.07 | 8.18± 0.09 | 6.42± 0.07 | 4.34± 0.06 | 1.51± 0.04 |
| | | 60 | 7.28± 0.03 | 9.98± 0.06 | 9.35± 0.08 | 7.71± 0.06 | 5.23± 0.05 | 1.56± 0.04 |
| Calcium (mg/l) | B B.T. | | 44.64 ± 0.02 | 97.04± 0.04 | 148.44± 0.04 | 197.85± 0.06 | 247.25± 0.07 | 296.65 ± 0.04 |
| | A.T. | 15 | 42.76± 0.04 | 77.80± 0.08 | 112.56± 0.08 | 147.34± 0.07 | 186.10± 0.07 | 241.42± 0.06 |
| | | 30 | 41.12± 0.03 | 70.24± 0.07 | 97.99± 0.08 | 125.76± 0.07 | 157.51± 0.06 | 216.86± 0.06 |
| | | 60 | 39.23± 0.02 | 60.38± 0.06 | 79.00± 0.07 | 97.62± 0.07 | 124.24± 0.06 | 199.57± 0.04 |
| Potassium (mg/l) | B.T. | | 25.59± 0.02 | 46.11± 0.03 | 65.63± 0.06 | 83.11± 0.06 | 100.62± 0.08 | 118.12± 0.04 |
| | A.T. | 15 | 24.64± 0.03 | 35.77± 0.08 | 47.51± 0.08 | 59.26± 0.07 | 72.00± 0.07 | 102.23± 0.06 |
| | | 30 | 23.96± 0.02 | 32.81± 0.07 | 41.81± 0.08 | 50.97± 0.06 | 63.13± 0.06 | 95.32± 0.04 |
| | | 60 | 22.98± 0.02 | 27.77± 0.07 | 33.13± 0.07 | 38.47± 0.06 | 47.83± 0.06 | 85.29± 0.04 |
| Magnesium (mg/l) | B.T. | | 18.11± 0.02 | 41.92± 0.03 | 64.74± 0.04 | 85.54± 0.06 | 106.36± 0.07 | 127.17± 0.04 |
| | A.T. | 15 | 17.60± 0.04 | 32.30± 0.08 | 46.55± 0.08 | 59.81± 0.08 | 75.06± 0.07 | 104.31± 0.06 |
| | | 30 | 17.14± 0.03 | 28.50± 0.08 | 39.99± 0.08 | 51.13± 0.07 | 63.97± 0.06 | 96.46± 0.04 |
| | | 60 | 16.76± 0.03 | 25.30± 0.07 | 34.52± 0.07 | 44.83± 0.06 | 56.12± 0.05 | 87.43± 0.04 |
| | B.T. | | 20.86± 0.03 | 34.05± 0.04 | 52.25± 0.06 | 65.43± 0.06 | 78.63± 0.08 | 91.82± 0.03 |
| Sulphur (mg/l) | A.T. | 15 | 20.06± 0.04 | 27.92± 0.07 | 38.33± 0.08 | 47.72± 0.07 | 57.55± 0.07 | 78.26± 0.06 |
| | | 30 | 19.51± 0.03 | 24.76± 0.07 | 33.46± 0.08 | 39.14± 0.06 | 49.44± 0.06 | 69.10± 0.05 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 60 | 18.65± 0.03 | 22.38± 0.06 | 28.10± 0.08 | 32.12± 0.06 | 41.00± 0.06 | 63.87± 0.04 |
| Phosphorus (mg/l) | B.T. | | 0.74± 0.03 | 1.92± 0.04 | 3.11± 0.06 | 4.29± 0.07 | 5.45± 0.09 | 6.61± 0.04 |
| | A.T. | 15 | 0.70± 0.03 | 1.50± 0.06 | 2.29± 0.08 | 3.13± 0.07 | 3.98± 0.06 | 5.66± 0.06 |
| | | 30 | 0.68± 0.03 | 1.39± 0.06 | 2.04± 0.07 | 2.65± 0.06 | 3.45± 0.06 | 5.32± 0.04 |
| | | 60 | 0.66± 0.03 | 1.31± 0.04 | 1.73± 0.07 | 2.12± 0.06 | 2.97± 0.05 | 4.98± 0.04 |
| Parameters | | Days | Percentage Wastewater | | | | | |
| | | | C | 20 | 40 | 60 | 80 | 100 |
| Nitrogen (mg/l) | B.T. | | 11.52± 0.03 | 21.93± 0.04 | 30.33± 0.06 | 38.74± 0.06 | 46.14± 0.08 | 53.55± 0.04 |
| | A.T. | 15 | 11.17± 0.04 | 17.83± 0.07 | 22.57± 0.08 | 27.62± 0.07 | 34.28± 0.06 | 46.25± 0.06 |
| | | 30 | 10.92± 0.03 | 16.36± 0.07 | 19.76± 0.08 | 24.14± 0.07 | 30.05± 0.06 | 43.23± 0.06 |
| | | 60 | 10.52± 0.03 | 14.95± 0.06 | 16.63± 0.08 | 19.44± 0.06 | 24.56± 0.05 | 40.86± 0.04 |
| Iron (mg/l) | B.T. | | 0.27± 0.02 | 0.68± 0.03 | 1.08± 0.04 | 1.47± 0.06 | 1.85± 0.07 | 2.16 ± 0.04 |
| | A.T. | 15 | 0.24± 0.03 | 0.52± 0.04 | 0.80± 0.05 | 1.06± 0.07 | 1.35± 0.08 | 1.76± 0.06 |
| | | 30 | 0.22± 0.03 | 0.45± 0.03 | 0.70± 0.05 | 0.92± 0.06 | 1.18± 0.07 | 1.63± 0.04 |
| | | 60 | 0.20± 0.03 | 0.39± 0.03 | 0.55± 0.04 | 0.68± 0.06 | 0.92± 0.06 | 1.47± 0.04 |
| Manganese (mg/l) | B.T. | | 0.016± 0.002 | 0.051± 0.003 | 0.085± 0.006 | 0.114± 0.007 | 0.148± 0.008 | 0.180± 0.003 |
| | A.T. | 15 | 0.013± 0.002 | 0.038± 0.003 | 0.061± 0.007 | 0.078± 0.007 | 0.104± 0.006 | 0.142± 0.006 |
| | | 30 | 0.011± 0.002 | 0.033± 0.002 | 0.053± 0.007 | 0.068± 0.006 | 0.092± 0.005 | 0.121± 0.004 |
| | | 60 | 0.010± 0.002 | 0.029± 0.002 | 0.042± 0.007 | 0.054± 0.006 | 0.072± 0.005 | 0.108± 0.003 |

B.T. = Before treatment; A.T. = After treatment; TDS = Total Dissolve Solids; TS = Total Solid; BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; EC = Electrical Conductivity; DO = Dissolve Oxygen

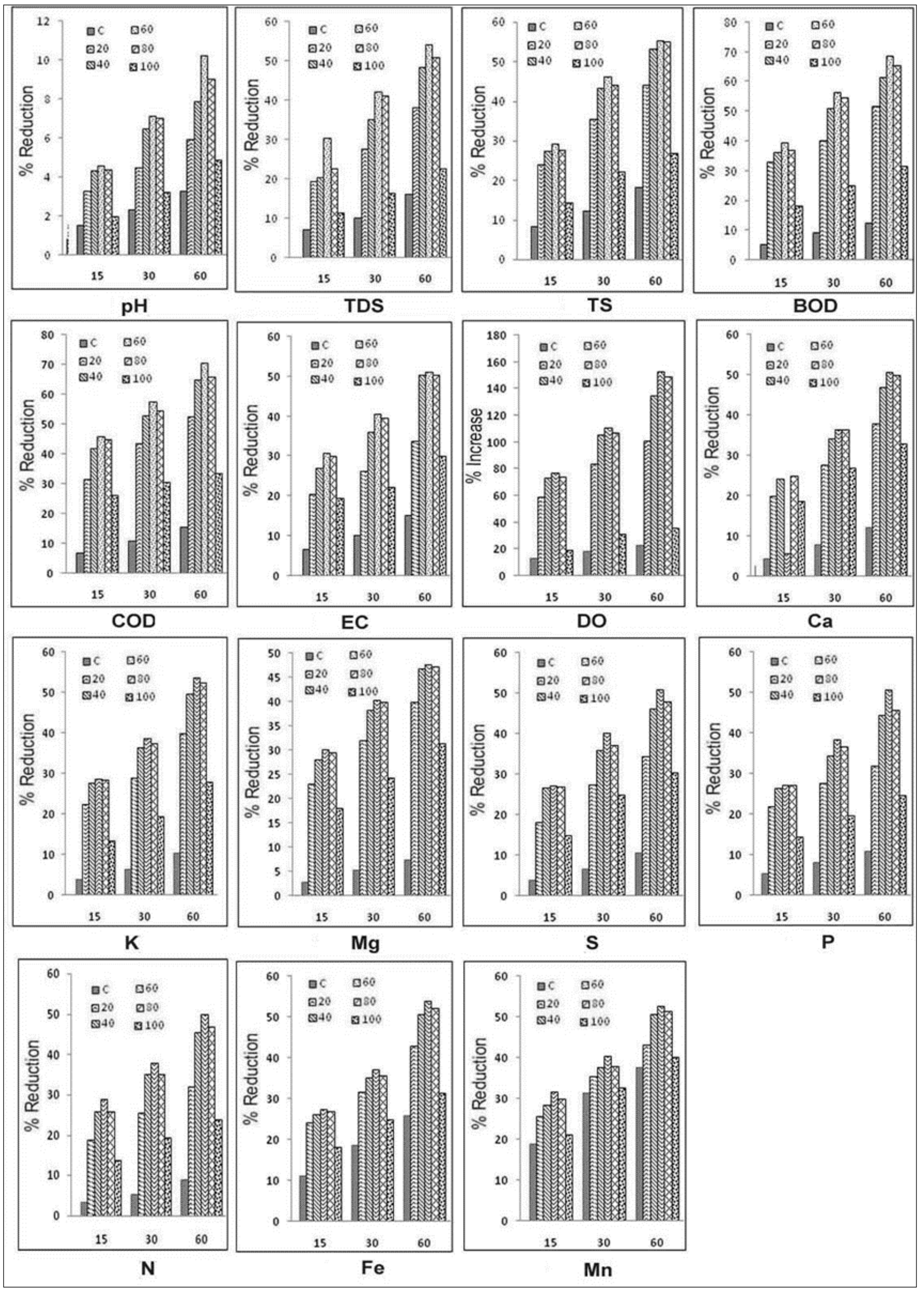


**Fig 1:** Graphical Representation of different Physico-chemical Parameter

## Conclusion

*Typha latifolia* (L.) perform very vibrant roles in the remediation of heavy metals from the polluted site with equal ease to other hyper-accumulator plants. Application of *Typha latifolia* (L.) Plants both in bioaccumulation can be done successfully for the eradication of heavy metals. Genetic engineering enhances the accumulation and tolerance capacity of plants, which shows its exceptional application in improving the effectiveness of phytoremediation. Genetically engineered plants show high tolerance and metal uptake capacity and, as a result, gene manipulation has successfully been investigated in terrestrial plants, but, genetic engineering of aquatic plants to enhance their heavy-metal uptake capacity is in its preliminary phases.

## References


1. Selin NE, Selin H. Global Politics of Mercury Pollution: The Need for Multi-Scale Governance. Review of European Community & International Environmental Law. 2006; 15:258-269.
2. Grace JB, Harrison JS. The biology of Canadian weeds. *Typha Iatifolia* L., *Typha angustifolia* L. and *Typha* x *glauca* Godr. Can. J. Plant Sci. 1986; 66:361-379.
3. Korner S *et al*. The capacity of duckweed to treat wastewater. Journal of Environmental Quality. 2003; 32(5):1583-1590.
4. Suppadit T. Treatment of effluent from shrimp farms using watermeal (*Wolffia arrhiza*). Science Asia. 2008; 134:163-8.
5. Fujita, M. *et al*. Nutrient removal and starch production through cultivation of Wolffia arrhiza. Journal of Bioscience and Bioengineering, 1999; 87(2):194-198.
6. Naskar K. Yield of *Wolffia arrhiza* (L.) Horkel ex Wimmer from cement cisterns with different sewage concentrations, and its efficacy as a carp feed. Aquaculture. 1986; 51(3-4):211-16.
7. Chareontesprasit N, Jiwayam W. An evaluation of*Wolffia* meal (*Wolffia arrhiza*) in replacing soybean meal in some formulated rations of Nile tilapia. Pakistan Journal of Biological Sciences. 2001; 4(5):618-20.
8. Greenberg AA, Connors JJ, David J. Standard Methods for the Examination of Water and Waste Water. 15th Ed. APHA, Washington, USA, 1980.
9. Tripathi BD, Govil SR. Water Pollution (An Experimental Approach). CBS Publishers & Distributers, New Delhi, 2001.
10. Wallace T. The Diagnosis of mineral deficiencies in plant. A colour allas and guide H.M.S.C., London, 1951.
11. Mason AC. The estimations of phosphorus, potassium, calcium, magnesium, iron, manganese and nitrogen in plant material. Ann. Rept. East Malling, Res. Sta, 1950, 111-115.
12. Chesnin L, Yen CR. Turbidimetric determination available sulphates, Soil Science, Soc. Amer. Proc. 1951; 15:149-151.
13. Jackson ML. Soil chemical analysis. Constable and Co. Ltd., London, 1958.
14. Chibnall AC, Rees MW, Williams EP The total nitrogen content of the egg elbumin and other protein. Biochem. J. 1943; 37:354-359.
15. Humphries EC. Mineral components and ash analysis in "Modern Methoden der Pflanzenanelyse" B and I.Ed. K. Peach U.M.V. Treacey. Springer Verleg. Berlin, Zeite, 1956, 468-502.
16. Nicholas DJD, Fischer DJ. A note on the use of tetramethylmethane for determining small amount of manganese in plants. Annu. Rep. Long Ashton. Res. Sta. Bristol. 1950; 1(20):115-120.
17. Liu JT, Sun JJ, Fang SW, Han L, Feng Q, Hu F. Nutrient removal capacities of four submerged macrophytes in the Poyang lake basin. Appl Ecol Environ Res. 2016; 14(2):107-124.
18. Kumar JE, Suganya K, Sebastian SP, Kannan TG. Changes in Physico-Chemical Characteristics of the Sewage Effluent under Constructed Wetland Technology Treatment. Madras Agric. J. 2019; 106(1-3):58-62.
19. Arivoli A, Mohanraj R. Efficacy of *Typha angustifolia* based vertical flow constructed wetland system in pollutant reduction of domestic wastewater. International Journal of Environmental Sciences,. 2013; 3(5):1497-1508.
20. Stowell R, Ludwig R, Colt J, Tchobanouglous G. Concept in aquatic treatment systems design, Journal environmental engineering division. ASCE. 1981; 107(25):919-940.
21. Suganya K Sebastian, SP. Phytoremediation prospective of Indian shot (Canna indica) in treating the sewage effluent through hybrid reed bed (HRB) technology. IJCS. 2017; 5(4):102-105.
22. Wu M. Potential of Typha as Plant candidates for sludge treatment wetland. GSTF Journal of Biosciences. 2014; 3(1):21-28.
23. Sankar U. Economic analysis of environmental problems industries, UNDP, Report Chennai Madras School of economies allied Publishers, New Delhi, 2000.
24. Kadlec RH, Knignt RL. Treatement wetlands. CRC Press/lewis Publishers, Boca raton, Florida, 1996, 893.
25. Mashauri DA, Mulungu DMM, Abdulhussein BS. Constructed wetland at the University of Dar Es Salaam. Water Research. 2000; 34:1135-1144.
26. Vymazal J. The use of subsurface flow constructed for wastewater treatment in the Czech Republic: 10 years' experience. Ecological Engineering. 2002; 18:633-646.
27. Steer D, Fraser L, Boddy J, seibert B. Efficiency of small constructed wetlands for subsurface treatment of single-family domestic effluent. Ecological engineering. 2003; 18:429-44.
28. Hench KR, Bissonnette GK, Sexstone AJ, Coleman JG, Garbutt K, Skousen JG. Fate of physical, chemical, and microbial contaminants in domestic wastewater following treatment by small constructed wetlands. Water research. 2003; 37:921-927.
29. DeBusk TA, DeBusk WF. Wetlands for water treatment', in D.M. Kent (ed.),Wetlands science and technology, 2nd edn, CRC Press, Boca Raton, USA, 2001.
30. Aziz S, Ali M, Asghar S, Ahmed S. Comparative Analysis of *Ranunculus muricatus* and *Typha latifolia* as Wetland Plants Applied for Domestic Wastewater Treatment in a Mesocosm Scale Study. International Journal of Environmental and Ecological Engineering. 2015; 9(1):110-118.

31. Vacca S. Bioretention Facilities and Constructed Wetlands Efficiency and Use: A Review, 2011.
32. Brix H. Do macrophytes play a role in constructed treatment wet Lands. WST. 1997; 35(5):11-17.
33. Stottmeister U, Wießner A, Kuschk P, Kappelmeyer U, Kastner M, Bederski O, Muller RA, Moormann H. Effects of plants and microorganisms in constructed wetlands for wastewater treatment. Biotechnology Advances. 2003; 22(1):93-117.
34. Oladejo OS, Olanipekun AA. Phytoremediation of Municipal Run-off using *Typha Orientalis* and *Sorghum arundinaceum* in Sub- Surface Constructed Wetland System. International Research Journal of Advanced Engineering and Science. 2018; 3(1):211-215.
35. Alalade O, Ferguson J, Pichtel J. Treatment of simulated oil and gas wastewater using Typha latifolia in a pilot scale constructed wetland. Environmental Biotechnology. 2017; 13 (1):1-10.
36. Pedescoll A, Sidrach-Cardona R, Hijosa-Valsero M, Bécares E. Design parameters affecting metals removal in horizontal constructed wetlands for domestic wastewater treatment. Ecol. Eng. 2015; 80:92-99.
37. Oladejo OS, Olanipekun A, Dahunsi SO. Municipal Runoff Remediation Using Typha orientalis and Sorghum arundinaceum. J. Environ. Sci. Technol. 2019; 12 (1):47-54.
38. Nakphet S, Ritchie RJ, Kiriratnikom S. Aquatic plants for bioremediation in red hybrid tilapia (*Oreochromis niloticus* × *Oreochromis mossambicus*) recirculating aquaculture. Aquac. Int. 2017; 25:619-633.
39. Pride RE, Nohrstedt SJ, Benefield LD. Utilization of created wetlands to upgrade small municipal wastewater systems. Water, Air and Soil Pollution. 1990; 50:371-385.
40. Martin CD, Moshiri GA. Nutrient reduction in an in-series constructed wetland system treating landfill leachate. Water Science Technology. 1994; 29(4):267-272.
41. Maine MA, Duarte MV, Sune NL. Cadmium uptake by floating macrophytes. Water Res. 2001; 35(11):2629-2634.
42. Morari F, Dal Ferro N, Cocco E. Municipal wastewater treatment with Phragmites australis L. and *Typha latifolia* L. for irrigation reuse. Boron and heavy metals. Water Air Soil Pollut. 2015; 226:56.
43. Mojiri A. Phytoremediation of heavy metals from municipal wastewater by *Typha domingensis*. Afr. J. Microbiol. Res. 2012; 6:643-647.